

## **SOW for Filament Winding of Hierarchical Rod Bundles**

### **The job will entail the following:**

1. Develop fixturing/process for rod-bundle winding.
2. Filament winding 18 inch and 12 inch long rod bundles with carbon-epoxy at ~ 0 degree angle to rod-bundle axis (circumferential hoop winding). Four layers thick of carbon-epoxy to achieve ~1 mm winding thickness.

### **Job Specifications: (see attached schematic drawings)**

1. Rod materials: S5 tool steel, MAX-Phase ternary carbide, and alumina. These rods will be supplied by NRL in 18 or 12 inch lengths. Rods will be supplied in a “clean” condition, however, minor “cleaning” prior to assembly/filament winding may be required (tbd). Commercial-off-the-shelf rods supplied by Carleton (e.g., W1 tool steel) can be used for process development.
2. Rod diameters: varying from approximately 0.25 to 1.0 inches.
3. Bundle geometries: hexagonal array patterns (Figure 1)
  - a. Small diameter rods → 37 rod hexagonal array pattern (Figure 2)
  - b. Mid-diameter rods → 19 rod hexagonal array pattern (Figure 3)
  - c. Large-diameter rods → 7 rod hexagonal array pattern (Figure 4)
4. Rod-gap dimension will vary from ~10 to 20% of rod-diameters.
5. Acrylic “snowflake” templates (Figure 5) will be supplied (by NRL) to hold rods in desired hexagonal pattern during initial epoxy potting for filament winding fixturing. NRL can also supply drawing of snowflake for laser or water-jet cutting from a different material (e.g., aluminum).
6. Potting at the ends of the rod bundles is acceptable (1 inch or less on both ends??).
7. Filament winding quantities (initial estimate):
  - a. S5 tool steel rod-bundles: ~ 24 bundles total comprised of 8 bundles each of 0.31, 0.51, and 1.01 inch diameter rods. All bundles 18 inch in length.
  - b. MAX-Phase rod-bundles: ~ 16 bundles total (guesstimate) comprised of 4 bundles of ~ 0.25 inch diameter rods; 4 bundles of ~ 0.75 inch diameter rods; and 8 bundles of ~ 0.50 inch diameter rods. All bundles 18 inch in length.
  - c. Alumina rod-bundles: ~ 6 bundles total comprised of 2 bundles each of 0.25, 0.50, and 1.00 inch diameter. All bundles 12 inch in length.